PATENT ABSTRACTS OF JAPAN

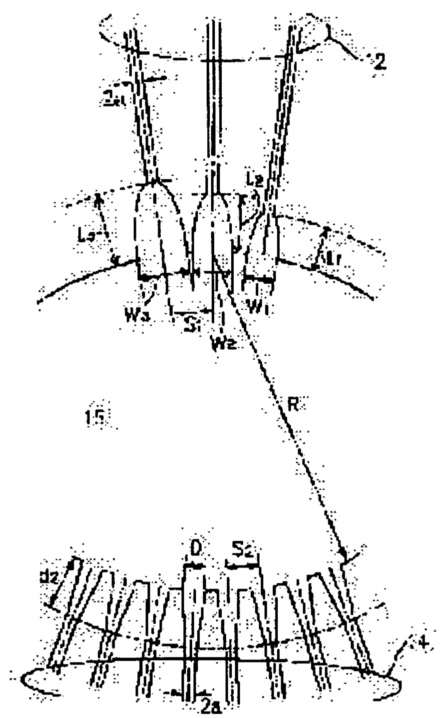
(11)Publication number : 10-197735
(43)Date of publication of application : 31.07.1998

(51)Int.Cl. G02B 6/122
G02B 6/12

(21)Application number : 09-004519
(22)Date of filing : 14.01.1997

(71)Applicant : NIPPON TELEGR & TELEPH CORP <NTT>
(72)Inventor : OKAMOTO KATSUNARI
OMORI YASUJI

(54) FLAT BAND CHARACTERISTIC ARRAY WAVEGUIDE GRATING



(57)Abstract:
PROBLEM TO BE SOLVED: To provide the array waveguide grating which can selectively vary the optical frequency width of flat band characteristics at a system's request.
SOLUTION: The array waveguide grating is equipped with an input channel waveguide 12, a channel waveguide array 14, an output channel waveguide, a 1st sectorial slab waveguide array 15, and a 2nd sectorial slab waveguide; and the cores of respective input waveguides of the input channel waveguide 12 nearby the border of the 1st sectorial slab waveguide 15 spread in a parabolic shape and the widths W1, W2, and W3 of the adjacent input waveguide cores in the parabolic shape are different from one another. Consequently, a light distribution having a flat electric field distribution is formed at the border between the 2nd sectorial slab waveguide and output waveguide, and light is inputted selectively to the input channel waveguides with mutually different parabolic core widths to obtain flat light frequency characteristics.

LEGAL STATUS

[Date of request for examination]	28.12.1998
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3224086
[Date of registration]	24.08.2001
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the flat band property array waveguide grid which can realize the array waveguide type light multi/demulitiplexer which has a flat optical-frequency band property.
[0002]
[Description of the Prior Art] Drawing 1 shows an example of the conventional array waveguide grid. This array waveguide grid The channel waveguide 2 for an input arranged on a substrate 1, the channel waveguide array 4, the channel waveguide 3 for an output, the 1st fanning slab waveguide 5 that connects the above-mentioned channel waveguide 2 for an input, and the channel waveguide array 4, and the above-mentioned channel waveguide array 4 and the channel waveguide 3 for an output It has the 2nd fanning slab waveguide 6 to connect, and it is constituted so that the length of the above-mentioned channel waveguide array 4 may become long one by one by predetermined waveguide length difference deltaL.
[0003] In such a conventional array waveguide grid, as shown in the enlarged view near the above-mentioned 1st fanning slab waveguide 5 of drawing 2 , it connected by the waveguide (it is also called a taper waveguide) of the taper configuration in which the core of each waveguide of the channel waveguide 2 for an input and the channel waveguide array 4 spreads in the shape of a straight line on a boundary with the 1st fanning slab waveguide 5. Moreover, similarly, as shown in the enlarged view near the 2nd fanning slab waveguide 6 of drawing 3 , it connected with the 2nd fanning slab waveguide 6 by the waveguide of the taper configuration in which the core of each waveguide of the channel waveguide 3 for an output and the channel waveguide array 4 spreads in the shape of a straight line on a boundary with the 2nd fanning slab waveguide 6.
[0004] In drawing 2 and drawing 3 R In addition, the 1st, radius of curvature of the 2nd fanning slab waveguide 5 and 6, U The object for an input, the core opening width of face of the taper configuration of the channel waveguides 2 and 3 for an output, S1 The interval of the object for an input, and the channel waveguides 2 and 3 for an output, and d1 For an input, The length of the waveguide of the taper configuration of the channel waveguides 2 and 3 for an output and D The core opening width of face of the waveguide of the taper configuration of the channel waveguide array 4, 2a is the core width of face of a channel waveguide portion, and S2 is the interval of each waveguide of the channel waveguide array 4, and d2. It is the length of the waveguide of the taper configuration of the channel waveguide array 4.
[0005]
[Problem(s) to be Solved by the Invention] As the frequency characteristic of such a conventional array waveguide grid is shown in drawing 4 , it becomes the loss property of a parabolic near the main optical frequency (in the case of drawing 4 , it is 0.0016 micrometers when it converts into a 200GHz interval and wavelength) of each waveguide, and 1dB frequency bandwidth is B1dB=35 (GHz) grade.
[0006] Thus, with the array waveguide grid of the conventional structure mentioned above, since it had

the loss property of a parabolic, when the wavelength (optical frequency) of a laser light source was changed from the main wavelength (main optical frequency) of each signal channel (waveguide) by the temperature change etc., the technical problem which should be solved that loss will increase sharply occurred.

[0007] In order that the purpose of this invention may solve the technical problem of the above conventional technology, it can change the frequency span of a flat band property, and is to offer the flat band property array waveguide grid which can choose the frequency span of a flat band property according to the requirements of a system.

[0008]

[Means for Solving the Problem] The channel waveguide for an input by which this invention has been arranged on a substrate in order to attain the above-mentioned purpose, The 1st fanning slab waveguide which connects a channel waveguide array, the channel waveguide for an output, the aforementioned channel waveguide for an input, and the aforementioned channel waveguide array, In the array waveguide grid constituted so that the 2nd fanning slab waveguide which connects the aforementioned channel waveguide array and the aforementioned channel waveguide for an output might be provided and the length of the aforementioned channel waveguide array might become long one by one with a predetermined waveguide length difference The core of each input waveguide of the aforementioned channel waveguide [near the boundary with the fanning slab waveguide of the above 1st] for an input has spread in the parabola configuration, and it is characterized by for the width of face of the core of the input waveguide of a ****** this parabola configuration differing respectively, and forming it.

[0009] Here, the parabola configuration of the core of each input waveguide of the aforementioned channel waveguide for an input is [0010].

[Equation 2]

$$y = \frac{1}{A_i}(a^2 - x^2)$$

[0011] (For 1 of core width of face / x, the position of the direction of core opening width of face and y are [the parameter and a with which correct and Ai specifies each parabola configuration to be] the position of the direction of an axis of a core) Suppose that it is decided by the formula. [2 and x]

[0012] In this invention, as mentioned above, when the core width of face of each input waveguide is making the parabola configuration [near the boundary of the 1st fanning slab waveguide and the channel waveguide array for an input], the optical distribution which has a flat electric-field distribution on the boundary of the 2nd fanning slab waveguide and the channel waveguide for an output is formed. For this reason, even if the frequency of the light source changes, the array waveguide grid which has a flat band property which becomes almost fixed [spectral separation output characteristics] is realizable. Furthermore, when the width of face of the input waveguide core of a ****** parabola configuration differs respectively, and light is inputted into a respectively different input waveguide, the width of face of the flat electric-field distribution formed on the boundary of the 2nd fanning slab waveguide and the channel waveguide for an output differs respectively.

[0013] Therefore, in this invention, by choosing an input waveguide, the frequency span of a flat band property can be changed and the frequency span of a flat band property can be chosen according to the requirements of a system. Moreover, thereby, the optical separator suitable for large capacity, long-distance optical communication, wavelength division routing, etc. can be offered.

[0014]

[Embodiments of the Invention] Hereafter, with reference to a drawing, the gestalt of operation of this invention is explained in detail.

[0015] Drawing 5 shows an array waveguide type light multi/demulitiplexer here as an example of the gestalt of operation of the flat band property array waveguide grid of this invention. In this optical multi/demulitiplexer, the 1st fanning slab waveguide 15 which connects the channel waveguide 12 for an input, the channel optical waveguide 13 for an output, the channel waveguide array 14, and the above-mentioned channel waveguide 12 for an input and the channel waveguide array 14, and the 2nd

fanning slab waveguide 16 which connects the above-mentioned channel waveguide array 14 and the channel waveguide 13 for an output are formed on the substrate 11. The channel waveguide array 14 is constituted so that the length may become long one by one by predetermined waveguide length difference deltaL.

[0016] Drawing 6 is the enlarged view near the fanning slab waveguide 15 of the above 1st showing the feature of this invention. As shown in drawing 6 , each core of the channel waveguide [near the boundary of the 1st fanning slab waveguide 15] 12 for an input is the parabola configuration from which the core width of face of a contiguity core differs respectively. On the other hand, the core of each waveguide of the channel waveguide array [near the boundary of the 1st fanning slab waveguide 15] 14 is the DEPA configuration which spreads in the shape of a straight line like the conventional example.

[0017] In drawing 6 , R is the radius of curvature of the 1st fanning slab waveguide 15, D is the core opening width of face of the waveguide of the taper configuration of the channel waveguide array 14, and 2a is the core width of face of a channel waveguide portion, and S2. The interval of the channel waveguide array 14, and d2 It is the taper length (the length of the taper configuration portion of a waveguide) of the channel waveguide array 14.

[0018] Moreover, Wi (referred to as i=1-3 with this operation gestalt) is the core opening width of face of each waveguide of the parabola configuration of the channel waveguide 12 for an input, and is S1. The interval of the channel waveguide 12 for an input and li (this operation gestalt i= 1-3) are the length of each parabola (parabola configuration portion of each waveguide) of the channel waveguide 12 for an input.

[0019] the Poral of the core of each waveguide of the channel waveguide [near the boundary with the 1st fanning slab waveguide 15] 12 for an input -- a bora -- if a configuration sets the direction of core opening width of face to x and the direction of an axis of a core is set to y as shown in the enlarged view of drawing 7 , it will be determined by the following formula (1) (However, Ai is a parameter which specifies each parabola configuration, and a is 1/2 (a core half width is called) of core width of face.)

[0020]

[Equation 3]

$$y=\frac{1}{A_i}(a^2-x^2) \qquad (1)$$

[0021] Now, in the composition of drawing 5 , the case where the signal light of optical frequency f (wavelength lambda=c/f:, however C are the velocity of light) carries out incidence to one port of the channel waveguide 12 for an input is considered. In case this light by which incidence was carried out passes through the field of the shape of a parabola shown in drawing 6 , it produces a flat electric-field distribution on a space target as shows an optical collimated beam-like distribution to drawing 8 on a boundary with nothing and the 1st fanning slab waveguide 15. The structure parameters for obtaining a flat light distribution as shown at drawing 8 in the case of the optical waveguide of core width-of-face 2a=7micrometer, core ** (thickness of core) 2t=7micrometer, and delta= 0.75% of refractive-index differences are A1 =1.0, l1 =250micrometer, A 2=1.1, l2 =300micrometer, A3 =1.2, and l3 =350micrometer.

[0022] Thus, the light with the obtained flat distribution spreads and progresses to a longitudinal direction in the 1st fanning slab waveguide 15 further, excites each waveguide of the channel waveguide array 14, and condenses in the 2nd fanning slab waveguide 16 in the position of the channel waveguide 13 for an output corresponding to optical frequency f.

[0023] At this time, the optical distribution in the boundary of the 2nd fanning slab waveguide 16 and the channel waveguide 13 for an output also turns into the same optical flat distribution as the distribution shown in above-mentioned drawing 8 as shown in drawing 9 by the reciprocity theorem.

[0024] Drawing 10 is an enlarged view near the 2nd fanning slab waveguide 16 of drawing 5 . The core of each waveguide of the channel waveguide [near the boundary of the 2nd fanning slab waveguide 16] 13 for an output and the channel waveguide array 14 is the DEPA configuration which spreads in the shape of a straight line like the conventional example. R is the radius of curvature of the 2nd fanning

slab waveguide 16, D is the core opening width of face of the waveguide of the taper configuration of the channel waveguide array 14 here, and 2a is the core width of face of a channel waveguide portion, and S2. The interval of the channel waveguide array 14, and d2 It is the taper length of the channel waveguide array 14. Moreover, U is the core opening width of face (all the same width of face) of the waveguide of the taper configuration of the channel waveguide 13 for an output, and S1 is the interval of the channel waveguide 13 for an output, and d1. It is the taper length of the channel waveguide 13 for an output.

[0025] It becomes almost fixed [the core opening width of face U of the waveguide of the channel waveguide 13 for an output / the amount of the light combined to the channel waveguide 13 for an output even if the optical frequency f of the light source changes somewhat, since it is designed so that it may drop to several / 1// compared with the width of face of an optical flat distribution shown in drawing 9]. That is, even if the frequency f of the light source changes somewhat, the flat frequency band property that a spectral separation output becomes almost fixed is realized.

[0026] Moreover, since the width of face of the optical distribution from the width of face Wi of a different parabola (the gestalt of this operation i= 1-3) differs respectively as shown in drawing 9 , the frequency span from which a spectral separation output becomes almost fixed is changeable by choosing the channel waveguide for an input.

[0027]

[Example] Furthermore, with reference to a drawing, one example of this invention is explained in detail.

[0028] The mask was produced using the following parameters about the array waveguide grid of this invention explained using drawing 5 - drawing 10 . Namely, 2a=7micrometer, R= 11.3mm delta L= 63 micrometers S 2 = 25 micrometers, They are D= 20 micrometers d 2 = 2mm S 1 = 25 micrometers, U= 10 micrometers, A1 =1.0, l1 =250micrometer, W1 =32micrometer, A2 =1.1, l2 =300micrometer, W2 =37micrometer, A3 =1.2, l3 =350micrometer, and W3 =42micrometer.

[0029] Thus, the flat band property array waveguide grid of this operation gestalt was produced using the quartz system optical waveguide with the produced mask.

[0030] First, it is SiO2 by the flame depositing method on the Si substrate 11. A lower clad layer is deposited and, next, it is GeO2. SiO2 added as a dopant After depositing the core layer of glass, transparent vitrification was carried out with the electric furnace. Next, the core layer was **********ed using the pattern as shown in drawing 5 based on the above-mentioned design, drawing 6 , and drawing 10 , and the optical-waveguide portion was produced. To the last, it is SiO2 again. The up clad layer was deposited.

[0031] Thus, the measurement result of the optical-frequency property of the produced flat band property array waveguide grid is shown in drawing 11 - drawing 13 (a frequency interval is 0.0016 micrometers when it converts into 200GHz and wavelength). Drawing 11 - drawing 13 are the width of face W1 of a parabola - W3 respectively. The measurement result of the frequency characteristic at the time of inputting light into the channel waveguide 12 for an input is shown.

[0032] As shown in drawing 11 , 1dB frequency bandwidth at the time of inputting light into the channel waveguide for an input of W1 =32micrometer parabola width of face is B1dB =116 (GHz). Moreover, as shown in drawing 12 , 1dB frequency bandwidth at the time of inputting light into the channel waveguide for an input of W2 =37micrometer parabola width of face is B1dB =140 (GHz). Moreover, as shown in drawing 13 , the 1dB frequency bandwidth at the time of inputting light into the channel waveguide for an input of W3 =42micrometer parabola width of face is B1dB =164 (GHz). The width of face W1 of a parabola - W3 which the optical-frequency property is flat-ized and are respectively different from drawing 11 - drawing 13 By inputting light into the channel waveguide for an input shows that the flat frequency characteristic of different bandwidth is obtained.

[0033] It turns out that it is obtained with the array waveguide grid whose flat frequency characteristic of different bandwidth by inputting light into the channel waveguide for an input of the width of face of the parabola which is sharply expanded by this, without 1dB bandwidth which was 35 (GHz) deteriorating the cross talk of an adjoining signal channel with the conventional array waveguide grid

(drawing 4), and changes respectively with it is one.
[0034]
[Effect of the Invention] As explained above, according to this invention, it sets near the boundary of the 1st fanning slab waveguide of an array waveguide grid, and the channel waveguide array for an input. the core of each input waveguide of the channel waveguide array for an input a parabola configuration Nothing, And since the width of face of the input waveguide core of a ****** parabola configuration differs respectively Without degrading the cross talk to an adjoining signal channel 1dB bandwidth, A flat bandwidth [by inputting light into the channel waveguide for an input of parabola width of face (opening width of face of the core of a parabola configuration) which can increase 3dB bandwidth sharply and is respectively different / different] optical-frequency property is acquired with the array waveguide grid whose number is one.
[0035] Therefore, since according to this invention passage loss does not increase even when the wavelength of the light sources, such as laser, is changed from the main wavelength of each signal channel by the temperature change etc., it has the advantage that the tolerance of designs, such as a wavelength division routing system, increases. Furthermore, according to this invention, by choosing an input waveguide, the frequency span of a flat band property can be changed and the remarkable effect that the frequency span of a flat band property is realizable with one array waveguide grid according to the requirements of a system is acquired.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] the flat band property array waveguide grid which it had the following , and the core of each input waveguide of the aforementioned channel waveguide [near the boundary with the fanning slab waveguide of the above 1st] for an input have spread in the parabola configuration in the array waveguide grid constituted so that the length of the aforementioned channel waveguide array might become long one by one with a predetermined waveguide length difference , and be characterize by for the width of face of the core of the input waveguide of a ****** this parabola configuration to differ respectively , The channel waveguide for an input arranged on a substrate. Channel waveguide array. The channel waveguide for an output. The 2nd fanning slab waveguide which connects the 1st fanning slab waveguide which connects the aforementioned channel waveguide for an input, and the aforementioned channel waveguide array, and the aforementioned channel waveguide array and the aforementioned channel waveguide for an output.
[Claim 2] The parabola configuration of the core of each input waveguide of the aforementioned channel waveguide for an input [Equation 1]

$$y = \frac{1}{A_i}(a^2 - x^2)$$

(For 1 of core width of face / x, the position of the direction of core opening width of face and y are [the parameter and a with which correct and Ai specifies each parabola configuration to be] the position of the direction of an axis of a core) The flat band property array waveguide grid according to claim 1 characterized by what it opts for by the formula. [2 and x]

[Translation done.]